present in only two out of 47 cases of cerebral infarct. In 20 out of 31 cases emboli had originated from extracranial vascular lesions, especially the carotids and the heart. Necropsy in one of the present cases (Case 6) showed the above, but in most angiography did not show any lesions in the carotids—though disease in the aortic arch and vessels arising from it could not be excluded.

Cardiac conditions predisposing to embolism are readily detected clinically, but an early cardiomyopathy may easily be missed (Case 43). Obscure cardiomyopathies are not uncommon in Ceylon, but the normal cardiac status in the present patients had not changed through the period of follow-up. Nevertheless, only longer follow-up could definitely exclude a cardiomyopathy.

The middle cerebral artery at its origin is a common site for atherosclerosis and the rarity of occlusive thrombosis at this site had been poorly understood. Factors leading to a thrombus formation are not yet clearly defined. Assuming that the occlusions in our cases were due to local thrombosis, perhaps special factors yet unknown in the young patients may have predisposed to a local thrombus. "Occult" embolism is an attractive alternative hypothesis for the causation of these strokes.

OCCLUSIONS IN WOMEN

Cross *et al.* (1968) found six cases of occlusion of the internal carotid in their Glasgow series of 31 cases of non-haemorrhagic carotid stroke associated with pregnancy and the puerperium. All except one occurred in the puerperium. In Jennett and Cross's (1967) series there were 42 non-pregnant women aged 15 to 45 of whom 11 had proved internal carotid occlusion. The general pattern of internal carotid occlusion in young women in our series was therefore similar to that seen in Western countries. Cross *et al.* (1968) also noted that occlusions during pregnancy were more often in the middle cerebral artery and that in the puerperium they were more often in the internal carotid.

In view of the observations of Lhermitte *et al.* (1970) that the middle cerebral artery is a rare site for primary thrombosis, it is tempting to postulate that fibrin clots generated elsewhere in the vascular system may lodge in the middle cerebral artery, a notorious site for embolism. This presumption is based on evidence that fibrinolysins are reduced during the second and third trimester of pregnancy (Bonner *et al.*, 1967). Furthermore, in this situation once a fibrin embolus is impacted extension may easily occur owing to lack of fibrinolytic factors. Unfortunately the literature is not clear on the necropsy findings in this type of case, though the absence of atherosclerotic narrowing is emphasized.

Thus, as in Western countries, ischaemic strokes are not uncommon in women in Ceylon aged 15 to 45, and most of them are either pregnant or in the puerperium.

We gratefully acknowledge the help of the late Professor G. H. Cooray, of the University of Ceylon, in interpreting histological sections, and we thank Professor K. Rajasuriya, director of health services, Ceylon, for permission to report this study.

References

Bickerstaff, E. R. (1964). *British Medical Journal*, **2**, 82.
Bonner, J., McNichol, G. P., and Douglas, A. S. (1967). In *Modern Trends in Obstetrics*, ed. R. J. Kellar. London, Butterworths.
Castiagne, P., Lhermitte, F., Gautier, J. C., Escourelle, R., and Derouesne, C. (1970). *Brain*, **93**, 231.
Cross, J. N., Castro, P. O., and Jennett, W. B. (1968). *British Medical Journal*, **3**, 214.
Dalal, P. M., Shah, P. M., and Aiyar, R. R. (1965). *Lancet*, **1**, 358.
Fisher, C. M. (1951). *Archives of Neurology and Psychiatry*, **65**, 346.
Fisher, C. M. (1954). *Archives of Neurology and Psychiatry*, **72**, 187.
Fisher, C. M. (1961). In *Pathogenesis and Treatment of Cerebrovascular Disease*, ed. W. S. Fields, p. 151, Springfield, Illinois, Thomas.
Humphrey, J. G., and Newton, T. H. (1960). *Brain*, **83**, 565.
Jennett, W. B., and Cross, J. N. (1967). *Lancet*, **1**, 1019.
Lhermitte, F., Gautier, J. C., and Derouesne, C. (1970). *Neurology (Minneapolis)*, **20**, 82.
Louis, S., and McDowell, F. (1967). *Annals of Internal Medicine*, **66**, 932.
McDowell, F. H. (1967). In *Cecil-Loeb Textbook of Medicine*, ed. P. B. Beeson and W. McDermott, 12th edn. p. 1545, Philadelphia, Saunders.
Sindermann, F., Bechinger, D., and Dichgans, J. (1970). *Brain*, **93**, 199.

Smoking and Gastro-oesophageal Reflux

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British Medical Journal, 1972, **3**, 793–795

Summary

Gastro-oesophageal sphincter pressure and intra-oesophageal pH has been studied in 25 chronic smokers who complained of heartburn. Smoking a cigarette invariably caused a fall in sphincter pressure, and pH measurements showed an increased tendency for reflux to occur while smoking. When lower oesophageal pH was measured overnight one-third of all reflux episodes occurred while the patients were smoking, and reflux was seen during the smoking of two-thirds of all the cigarettes consumed. It is concluded that cigarette smoking is a common reversible cause of gastro-oesophageal reflux.

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Introduction

Gastro-oesophageal reflux is probably the commonest form of digestive disturbances, and although it uncommonly gives rise to complications it can cause great discomfort to the patient and accounts for much clinical investigation.

The reason why reflux occurs is not entirely understood, but a competent gastro-oesophageal sphincter is the main barrier to reflux (Atkinson *et al.*, 1957; Pope, 1967; Winans and Harris, 1967; Longhi and Jordan, 1969). The mean gastro-oesophageal sphincter pressure in patients with reflux symptoms is lower than that in people without reflux (Atkinson *et al.*, 1957; Winans and Harris, 1967; Haddad, 1970; Benz *et al.*, 1972) though the primary reason for weakness of the gastro-oesphageal sphincter is unknown.

Studying a recent series of patients with gastro-oesophageal reflux we found that 92% were smokers, many of whom noticed that heartburn sometimes occurred while they smoked. Moreover, we discovered that during long recordings of lower oesophageal pH episodes of acid reflux were frequently detected when patients smoked. Dennish and Castell (1971) found that smoking led to a fall in gastro-oesophageal sphincter pressure in normal people. We therefore studied a group of smokers who

has symptomatic reflux to determine the effects of smoking on the sphincter and to measure its influence on acid reflux.

Patients and Methods

The 25 patients studied (16 men and 9 women) were aged 24 to 71 years (mean age 53·4 years). All had characteristic heartburn related to posture and meals, and 14 had radiologically proved gastro-oesophageal reflux. All were habitual smokers admitting to a consumption of 15 to 60 cigarettes daily.

Two polyethylene catheters were used, each with an internal diameter of 1·2 mm and having one lateral opening 2·4 mm in length near the sealed tip; the distance between the openings was 5 cm. The recording catheters were connected via pressure transducers to a multichannel direct-writing recorder (Devices M.19). The catheters were constantly perfused with water by means of an infusion pump at a rate of 0·8 ml/min. Respiration was recorded with a belt pneumograph. A combined glass/reference pH electrode (GK 282C) connected to a Radiometer pH meter, recording continuously on the same chart, was attached beside the distal opening, and the assembly (catheters and pH electrode) was inserted through the nose into the stomach.

With the patient supine the assembly was withdrawn in 0·5-cm steps until one tip was recording peak gastro-oesophageal sphincter pressure—that is, the highest sustained pressure above basal levels during quiet respiration without swallowing. Confirmation of normal sphincter relaxation during swallows was always obtained. Gastro-oesophageal sphincter pressure was then measured in three consecutive 15-minute periods—basal, puffing an unlit cigarette, and during smoking.

The assembly was reintroduced into the fundus and 300 ml of 0·1 N hydrochloric acid was instilled through the proximal catheter. After flushing, the assembly was withdrawn so that the distal opening and pH electrode were placed 5 cm above the gastro-oesophageal sphincter, and a standardized test for reflux was carried out by having the patient perform certain provocative manoeuvres—such as, deep breathing, coughing, Valsalva, and Muller—each being performed while supine, on left and right sides, and supine with a 15° head-down tilt. The manoeuvres were performed before and during smoking in 16 patients. In the other nine the test was first performed during smoking and then repeated 10 minutes after finishing the cigarette, when sphincter pressure had returned to normal.

Finally, a 15-hour recording of overnight lower oesophageal pH was made. The pH electrode was placed 5 cm above the cardia (the distance from nares to gastro-oesophageal sphincter being known from previous manometric studies) and its position was verified radiologically in the evening and next morning. The electrode lead was firmly anchored to the cheek and the electrode was checked next morning for standardization in buffers of known pH. The patients were allowed to smoke at will, and occasions when they smoked or had heartburn were noted. An episode of reflux was considered to have occurred when there was a fall in oesophageal pH of at least two units.

Results

The mean basal end-expiratory gastro-oesophageal sphincter pressure (±S.D.) was 10·8 ± 3·7 cm of water, falling to 6·4±2·9 cm of water during smoking. This drop is significant ($P < 0.01$). The fall began within one to four minutes of starting smoking and the pressure returned to its previous value three to eight minutes after finishing the cigarette. There was no significant change in pressure if the patient puffed an unlit cigarette (Figs. 1 and 2).

Before smoking the mean number of manoeuvres producing reflux was 6·9 rising to 10·7±3·3 during smoking, the difference being statistically significant ($P < 0.01$) (Fig. 3).

An example of a tracing obtained during a 15-hour recording of lower oesophageal pH is shown in Fig. 4. Taking the 25 patients as a whole, 226 episodes of reflux occurred during the overnight recording: 71 of them took place while smoking (one every 13·9 minutes), 26 followed within eight minutes of finishing a cigarette (one every 50·5 minutes), and 129 were not

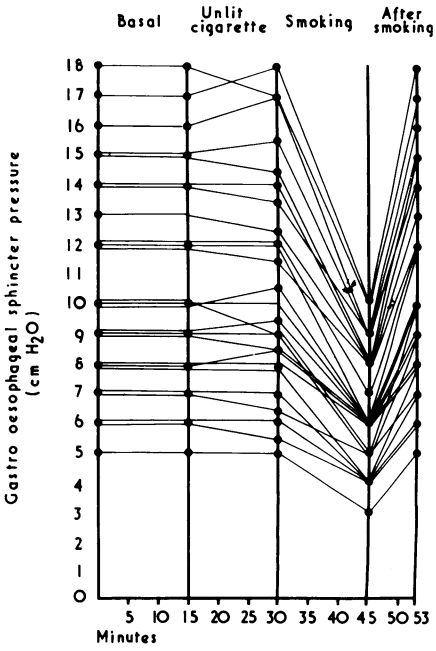

FIG. 1—Gastro-oesophageal sphincter pressures in all patients showing changes while puffing an unlit cigarette, during smoking, and 8 minutes after smoking.

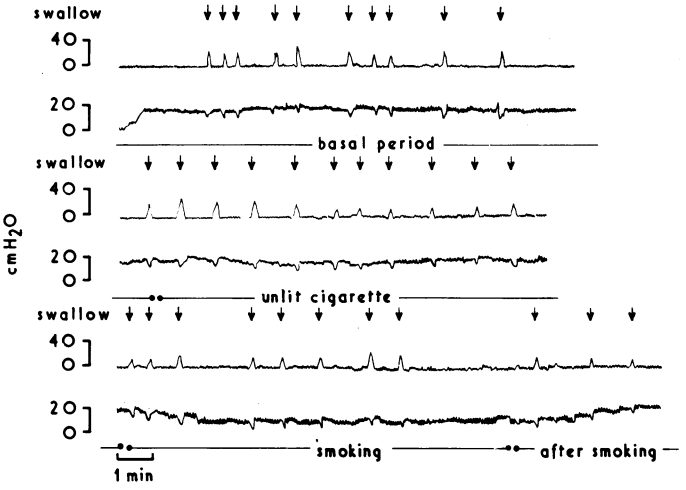

FIG. 2—Continuous recording of gastro-oesophageal pressure (lower trace) and pressure 5 cm above sphincter (upper trace) in a 41-year-old patient. Sphincter pressure remains constant at 15 cm of water (apart from relaxation induced by swallowing) throughout basal and unlit cigarette periods, but gradually falls to 9 cm of water while smoking. Pressure begins to rise as soon as smoking stops.

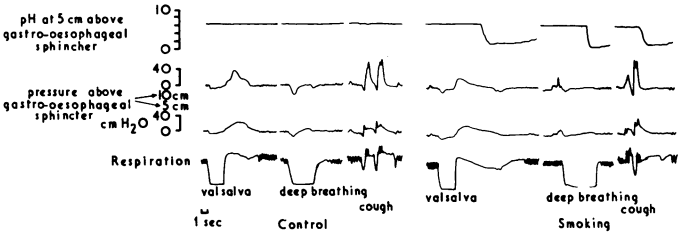

FIG. 3—Part of recording during provocative manoeuvres in a 34-year-old patient. Lower oesophageal pH (top trace) is not affected by a Valsalva manoeuvre, deep breathing, or coughing before smoking, but during cigarette smoking each manoeuvre causes a drop of pH of three to four units, indicating acid reflux.

connected with smoking. In the intervals between smoking an episode of reflux occurred once every 156·6 minutes ($\chi^2=416$ with 2 D.F., $P<0·001$).

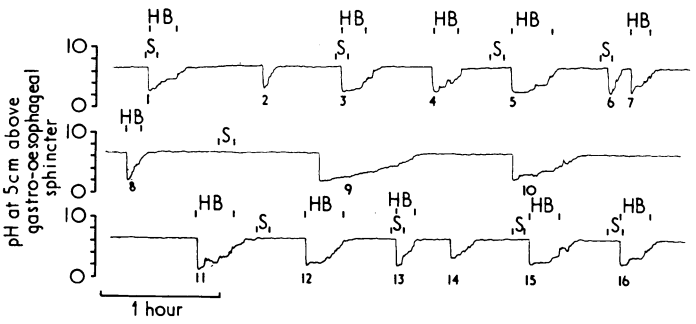

FIG. 4—Fifteen-hour recording of lower oesophageal pH in a 49-year-old patient. Nine cigarettes were smoked. Episodes 1, 3, 5, 6, 13, 15, and 16 occurred during or immediately after smoking. Two cigarettes were smoked without associated reflux. Heartburn occurred duirng 11 of the 16 reflux episodes. HB = Heartburn. S = Smoking.

The proportion of reflux episodes in the overnight recording which were associated with heartburn was not affected by the subject's smoking. Heartburn occurred with 68% of the smoking episodes of reflux, with 65% of the episodes after smoking, and with 56% of the non-smoking episodes ($P=0·1$).

The patients smoked 164 cigarettes (nearly seven each), and only 67 were smoked without associated reflux.

Discussion

The reason for the weakness of the gastro-oesophageal sphincter, which allows reflux to occur, is not known. Its anatomical situation has been thought to be crucial, though the work of Cohen and Harris (1971) casts doubt on the importance of this factor. The sphincter is under neural and hormonal control (Ellis *et al.*, 1960; Lind *et al.*, 1968; Castell and Harris, 1969; Giles *et al.*, 1969; Lipshutz and Cohen, 1971) but disturbances of these can rarely be found as the cause of a patient's reflux. In the great majority of patients with symptomatic reflux no fundamental reason can be found.

Similarly, although extrinsic factors influence the tone of the sphincter (anticholinergic drugs, intragastric pressure, intra-abdominal pressure) they have not been shown to *cause* chronic symptomatic reflux. This paper shows that smoking a cigarette reduces the gastro-oesophageal "barrier" pressure and may allow reflux, with accompanying symptoms, to occur. The probable mechanism is that inhaled nicotine blocks the cholinergic control mechanism. In-vitro nicotine causes relaxation of circular muscle fibres from the lower oesophagus (Ellis *et al.*, 1960; Misiewicz *et al.*, 1969).

We have also shown that the effects on the sphincter may take place with each successive cigarette. Gastro-oesophageal reflux may occur without symptoms (Skinner, 1966), but it is likely that heartburn is the product of frequent repeated reflux episodes over a sustained period—perhaps months or years. Chronic cigarette smoking could easily be the only extra factor needed to convert occasional asymptomatic reflux into frequent, painful reflux, and the corollary that stopping smoking may reverse the process is probably true.

The manometric apparatus was generously loaned by Reckitt & Colman Ltd., and our technical help was financed by the Wellcome Foundation. Mr. W. A. Pridmore gave us invaluable statistical advice. Carol Stanciu is the recipient of a research grant from the Leeds Regional Hospital Board.

References

Atkinson, M., Edwards, D. A. W., Honour, A. J., and Rowlands, E. N. (1957). *Lancet*, **2**, 1138.
Benz, L. J., *et al.* (1972). *Gastroenterology*, **62**, 1.
Castell, D. O., and Harris, L. D. (1969). *Gastroenterology*, **56**, 124.
Cohen, S., and Harris, L. D. (1971). *New England Journal of Medicine*, **284**, 1053.
Dennish, G. W., and Castell, D. O. (1971). *New England Journal of Medicine*, **284**, 1136.
Ellis, F. G., Kauntze, R., and Trounce, J. R. (1960). *British Journal of Surgery*, **47**, 466.
Giles, G. R., Mason, M. C., Humphries, C., and Clark, C. G. (1969). *Gut*, **10**, 730.
Haddad, J. K. (1970). *Gastroenterology*, **58**, 175.
Lind, J. F., Crispin, J. S., and McIver, D. K. (1968). *Canadian Journal of Physiology and Pharmacology*, **46**, 233.
Lipshutz, W., and Cohen, S. (1971). *Gastroenterology*, **61**, 16.
Longhi, E. H., and Jordan, P. H. (1969). *Surgery, Gynecology and Obstetrics*, **129**, 734.
Misiewicz, J. J., Waller, Sheila L., Anthony, P. P., and Gummer, J. W. P. (1969). *Quarterly Journal of Medicine*, **38**, 17.
Pope, C. E. (1967). *Gastroenterology*, **52**, 779.
Skinner, D. B. (1966). *American Journal of Digestive Disorders*, **11**, 771.
Winans, C. S., and Harris, L. D. (1967). *Gastroenterology*, **52**, 773.

Study of Chromosomes in the Newborn after Ultrasonic Fetal Heart Monitoring in Labour

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British Medical Journal, 1972, 3, 795–796

The effect of continuous-wave ultrasound on the chromosomes of newborn infants has been investigated. Twenty-four women were studied during labour. The fetal heart was monitored by a Sonicaid FM2 monitor applied to the abdomen, and continuous monitoring undertaken for intervals varying from 1 hour 5 minutes to 9 hours 25 minutes. There was no increase in the number of chromosome aberrations in cultures of blood taken from the insonated babies when compared with controls.

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Introduction

The use of diagnostic ultrasound in medicine, especially in obstetrics, has increased rapidly in recent years.

Antenatal investigation of the fetus with both pulsed and continuous-wave ultrasound has been established for many year (Willocks *et al.*, 1967; Campbell, 1968; Donald, 1968 Donald and Abdulla, 1968; Abdulla, 1971). Recently, diagnostic continuous-wave ultrasound has been introduced to monitor the fetal heart in labour.